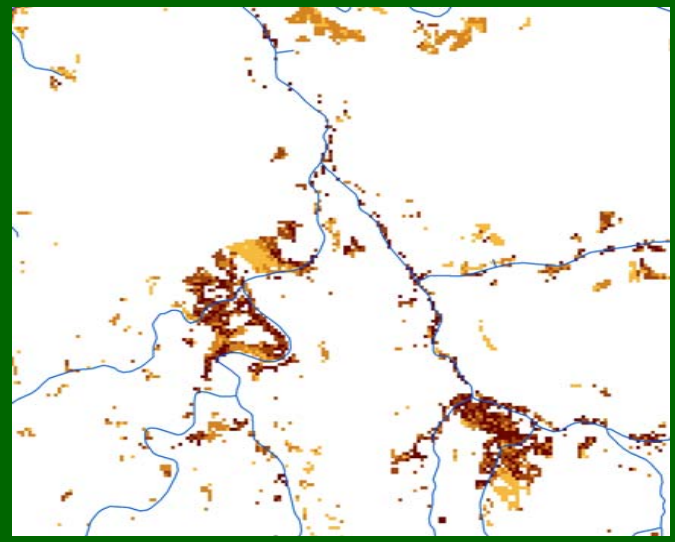
Application of FIA data to spatial modeling of landscape change and bird habitat suitability



D. Todd Farrand, John Tirpak,
Frank Thompson, Dan Twedt, and Bill Uihlein

April 12, 2006

Outline

- Overview of modeling with FIA
  - Why do it
  - Review current approaches
- Overview of our project
- Our approach to modeling with FIA
- Example
  - Process
  - Preliminary Output
- Caveats and opportunities

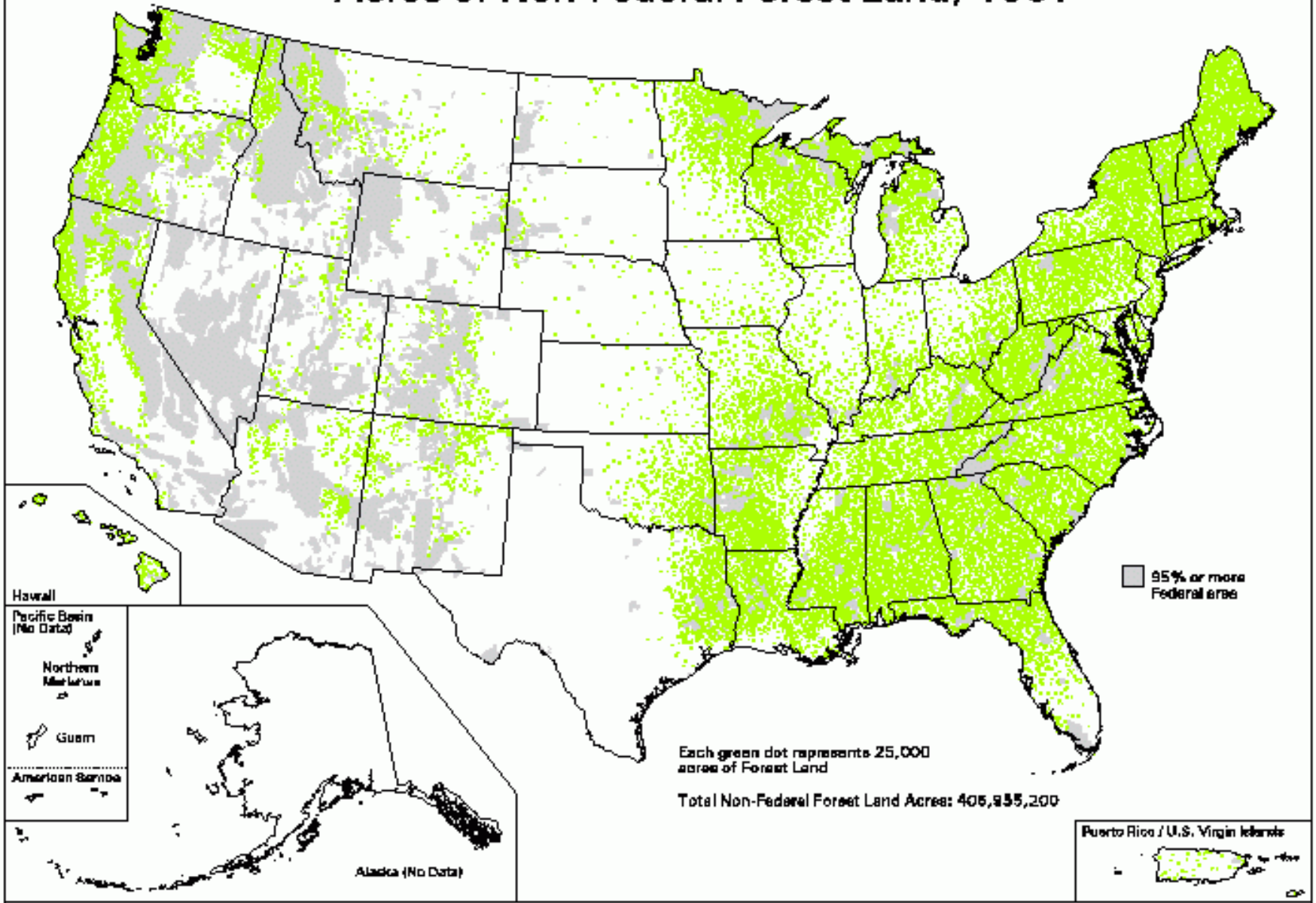
Modeling with FIA

- Why do it
  - Vegetation structure is important to birds
  - Existing spatial datasets are 2-D
  - Classification error (e.g., mixed forest)
  - All pixels are not equal
  - Habitat condition can change faster than habitat quantity
  - Private lands

Existing Approaches for Landscape Characterization with FIA Data

- Visual Characterization
  - Dot Map

Acres of Non-Federal Forest Land, 1997



USDA NRCS

U.S. Department of Agriculture
Natural Resources Conservation Service
Resource Assessment Division
Washington DC January 2001

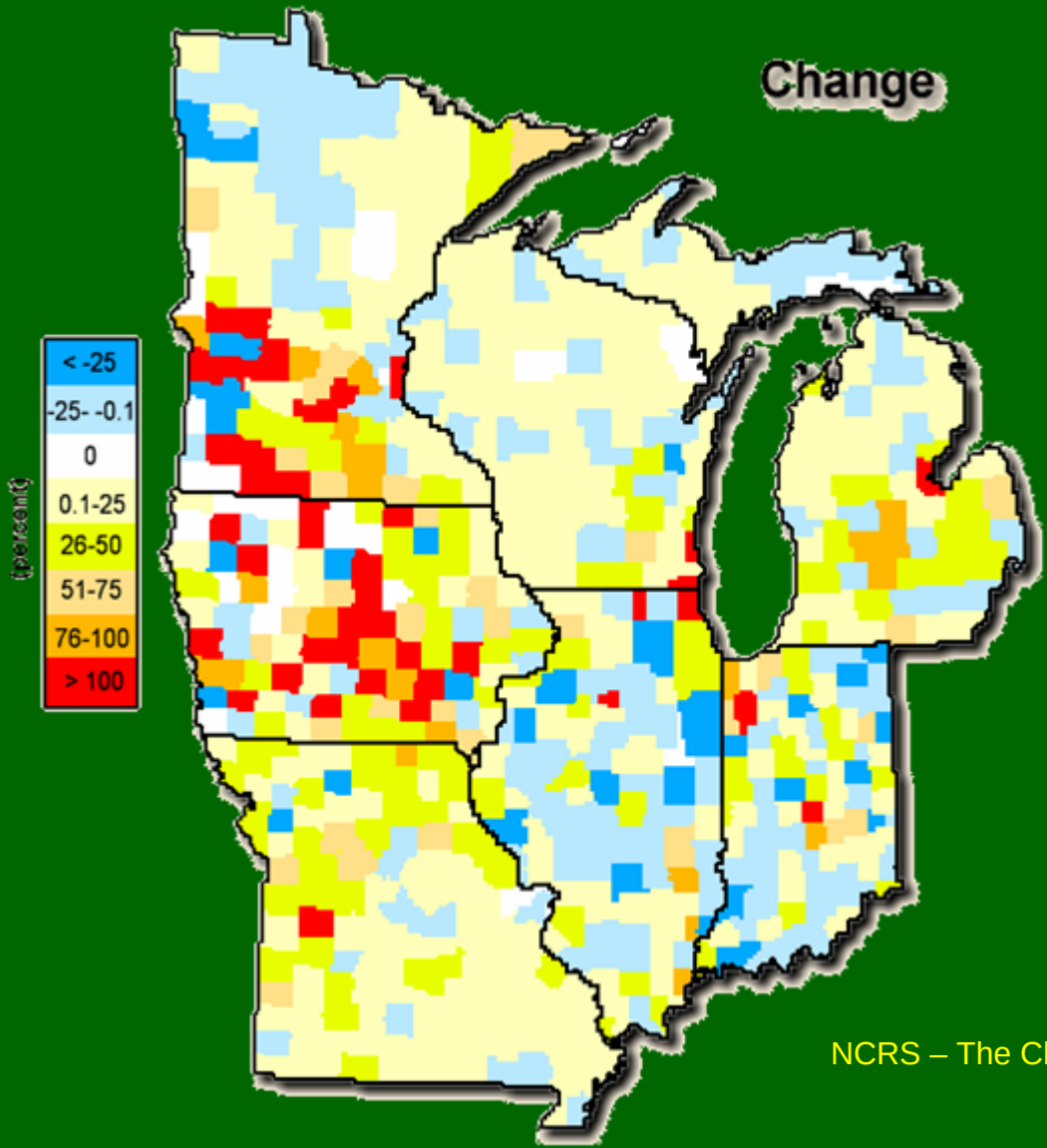
Map ID: nr4879
For proper interpretation, see Explanation of Analysis for this map at our web site. Search for "USDASOTL" to locate our map index.

Data Source: 1997 National Resources Inventory
Revised December 2000

Existing Approaches for Landscape Characterization with FIA Data

- Visual Characterization
- Systematic Summarization
  - County
  - EMAP hexagon
  - Hydrologic Unit (HUC)

Percent Change in Forest Area 1980 - 2000



NCRS – The Changing Midwest Assessment

Existing Approaches for Landscape Characterization with FIA Data

- Visual Characterization
- Systematic Summarization
- Geostatistics/Spatial Interpolation
  - Inverse distance
  - Kriging

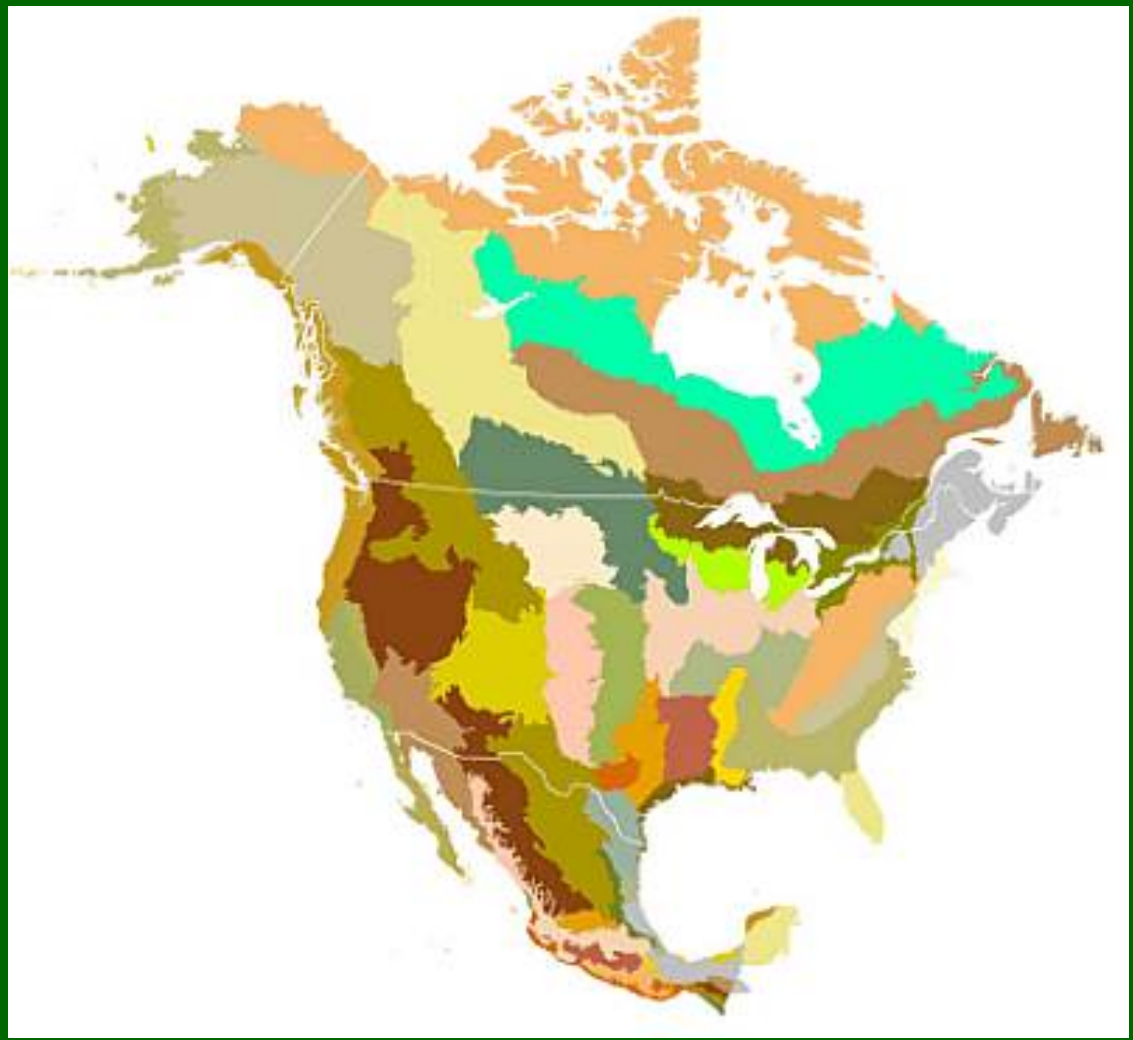
Existing Approaches for Landscape Characterization with FIA Data

- Visual Characterization
- Systematic Summarization
- Geostatistics/Spatial Interpolation
- Nearest Neighbor/Similarity Approaches
  - Spectral data
    - kNN
  - Multivariate relationships
    - CCA
    - Neural Networks

Existing Approaches for Landscape Characterization with FIA Data

- Visual Characterization
- Systematic Summarization
- Geostatistics/Spatial Interpolation
- Nearest Neighbor/Similarity Approaches
- Stratification
  - Ecologically meaningful strata
  - Multiple strata
  - Points not necessarily adjacent

Ecoregional Scale Landbird Conservation Planning in Forested Avifaunal Biomes



Purpose

- Assist JV's identify landscapes capable of sustaining bird populations at prescribed levels
  - Central Hardwoods (BCR 24)
  - West Gulf Costal Plain (BCR 25)
- Translate NALC target population numbers to habitat objectives within each region
  - Requires a link between habitat and populations
- Develop a transferable methodology

The Objectives

- Assessment
  - Determine if the current landscape can support a species
- Monitoring
  - Evaluate the ability of the landscape to continue to support a species
- Prediction
  - Appraise the effect future changes in the landscapes may have on a species

Which Species?

- Priority bird species within Central Hardwood or West Gulf Coastal Plain BCRs
  - PIF score >20 and/or USFWS Bird of Conservation Concern for either BCR (43 species)
- Add or delete species?
  - Not yet

Modeling Framework

- Best-biology available / HSI models
- Model density, not presence-absence
  - First suitability function
  - Presence alone poor indicator of sustainability
- Incorporate productivity into models
  - Second suitability function
  - True measure of sustainability

Identify Habitat Covariates

- Literature review
  - Presence/absence – detection probabilities
    - Absence: density = 0
  - Abundance – relative densities
  - Productivity – nest success, survival

The Habitat Data

- Nationally consistent datasets
- Primary data
  - Ecological Subsections
  - National Land Cover Dataset (NLCD)
  - National Elevation Dataset (NED)
    - Derived Landforms
  - Forest Inventory and Analysis (FIA) data
  - National Hydrography Dataset (NHD)

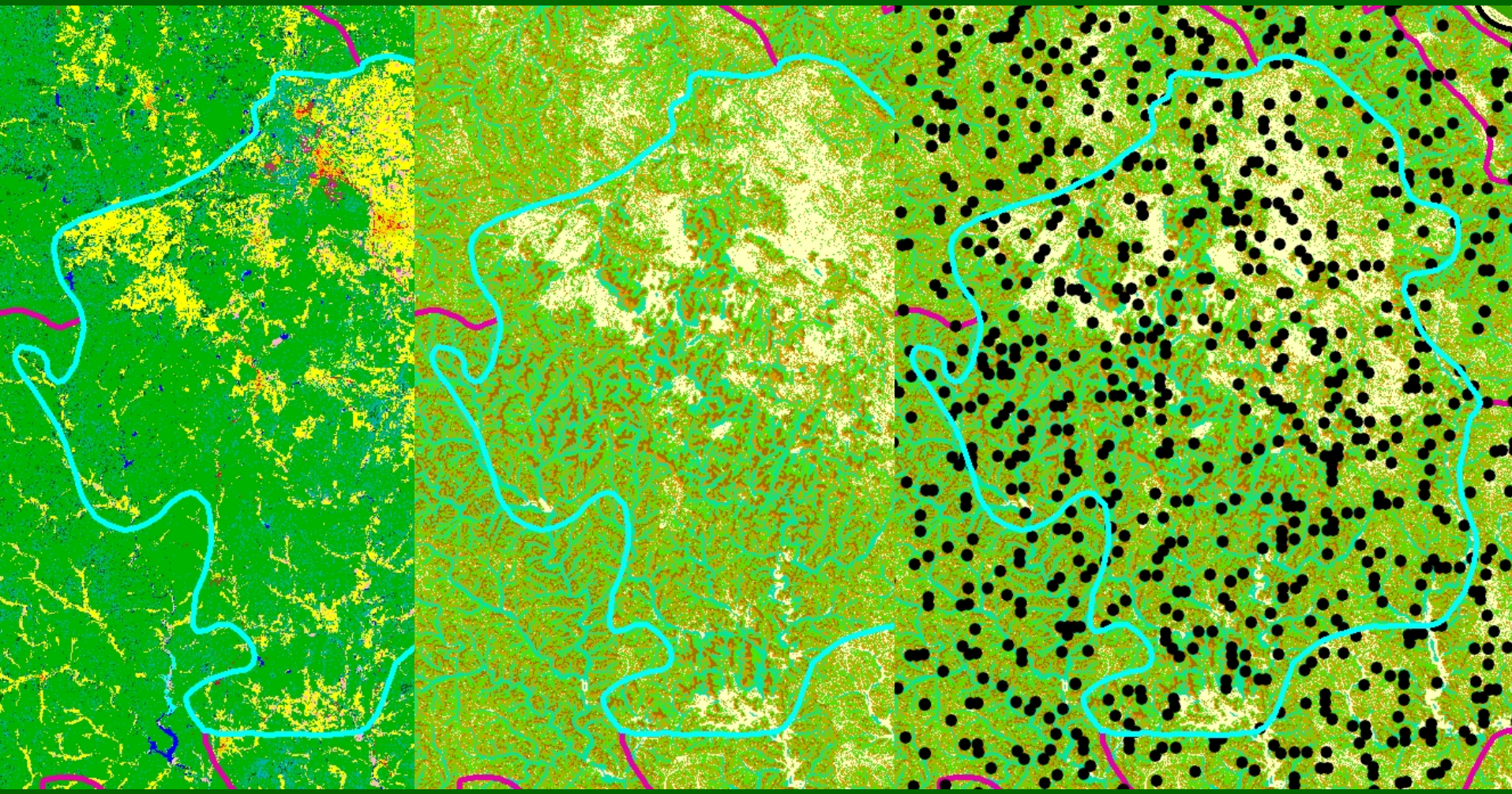
Desired Habitat Attributes

Landscape	FIA	DEM	NHD
Habitat/Non-habitat	Forest type	Landform	Distance to stream
Composition	Forest age	Slope	Stream Order
Interspersion	Basal area		
Contagion	Tree density		
Edge density	Snag density		
Distance to edge	Canopy cover		
Patch size	Midstory cover		
Core area	Shrub cover		

Our Current Approach

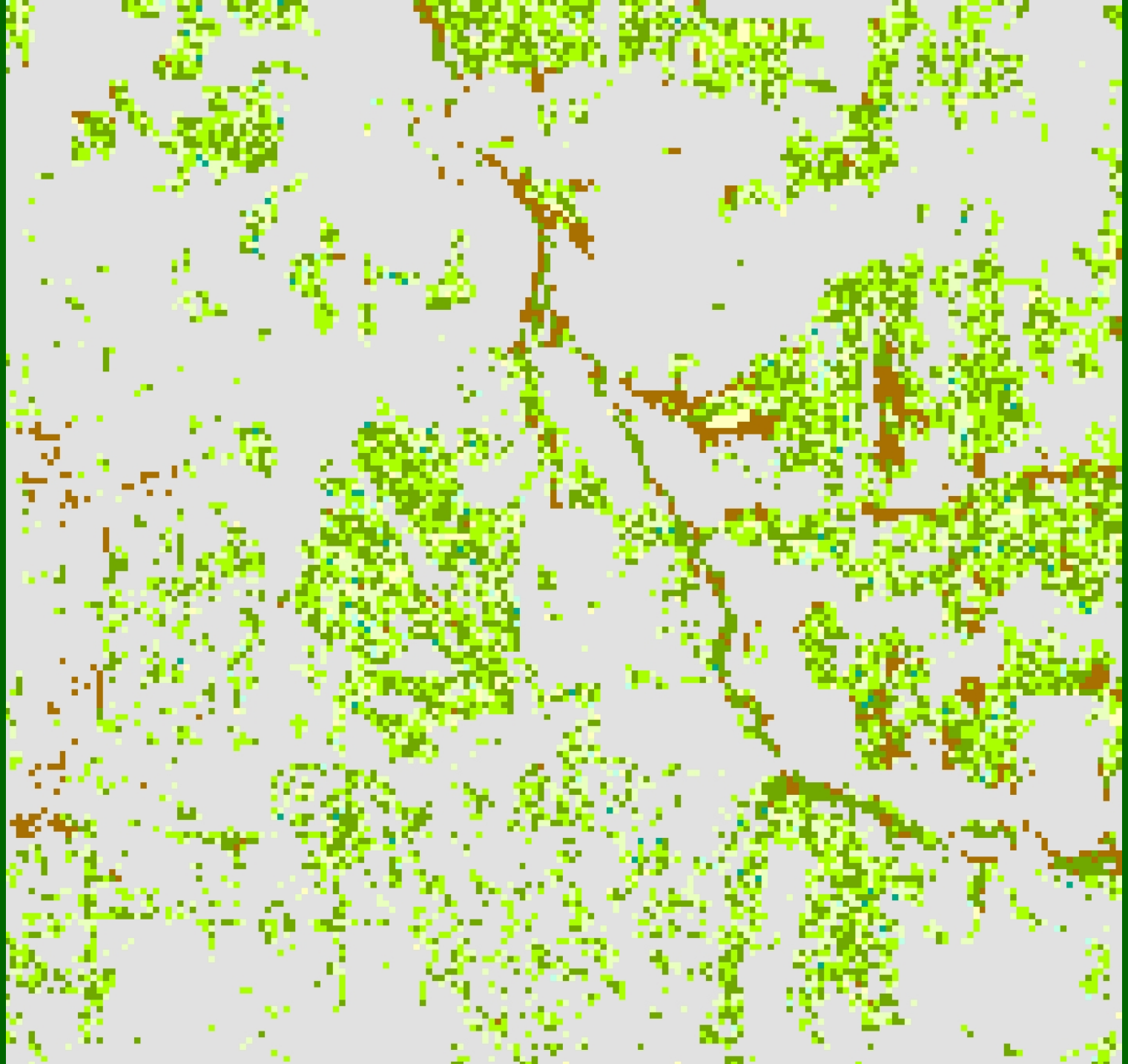
- Stratify FIA plots by combining ecological subsection, landform, and NLCD
- Draw from the distribution of plots within each strata
  - Define primary attributes
    - Forest type & Age class (size class)
- Draw from the distribution of plots within primary attributes
  - Define secondary attributes
    - Basal area, densities (tree, snag, shrub, midstory), canopy cover

Stratifying FIA



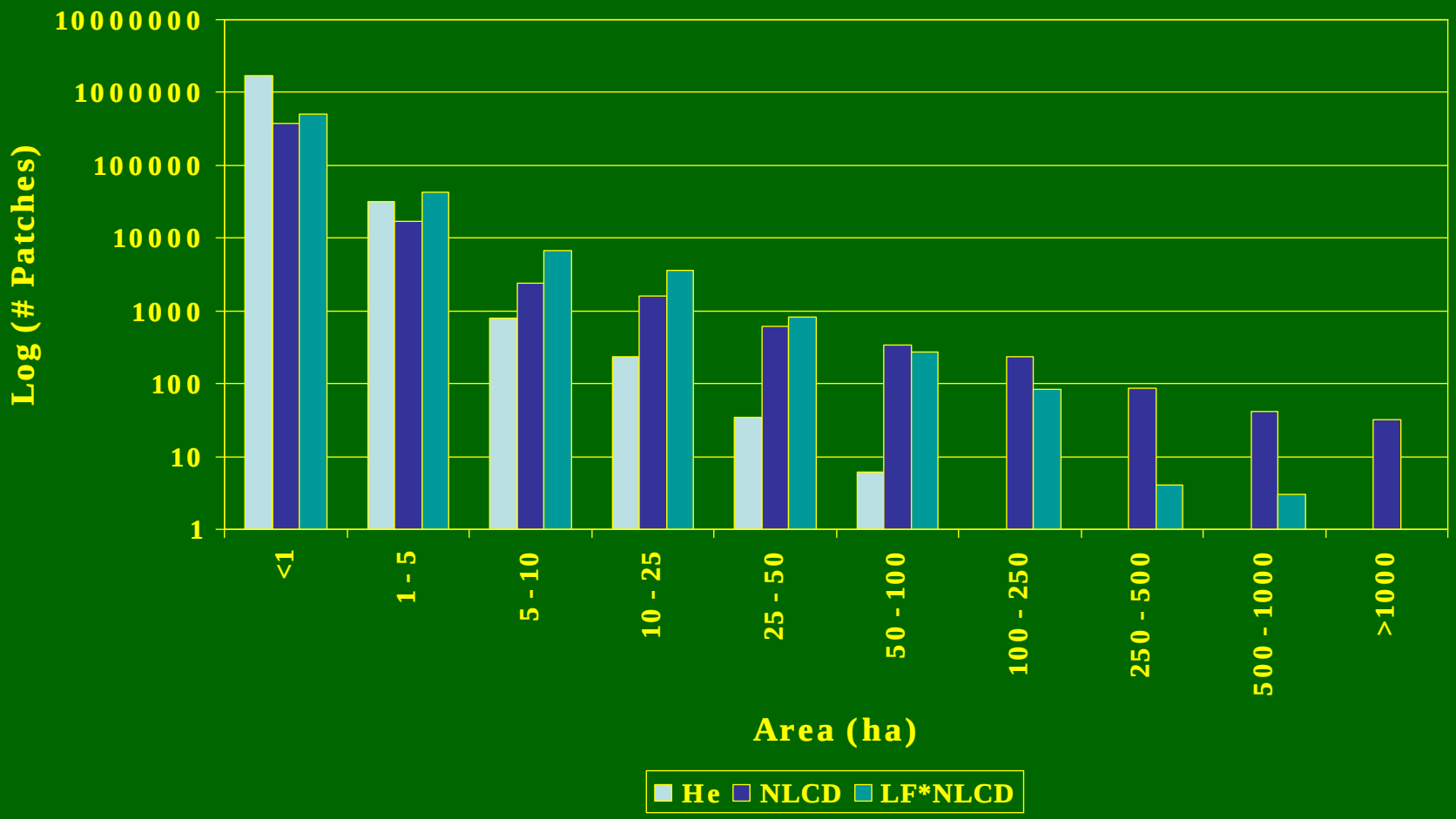
Populating Landscapes with FIA

- Dr. Hong He's algorithm
  - Ecological Applications 8:1072-1083
  - Stratified populations
  - Probability distribution
- Pixel-based assignment
  - Representative structure over large areas
  - Patch structure skewed towards small patches



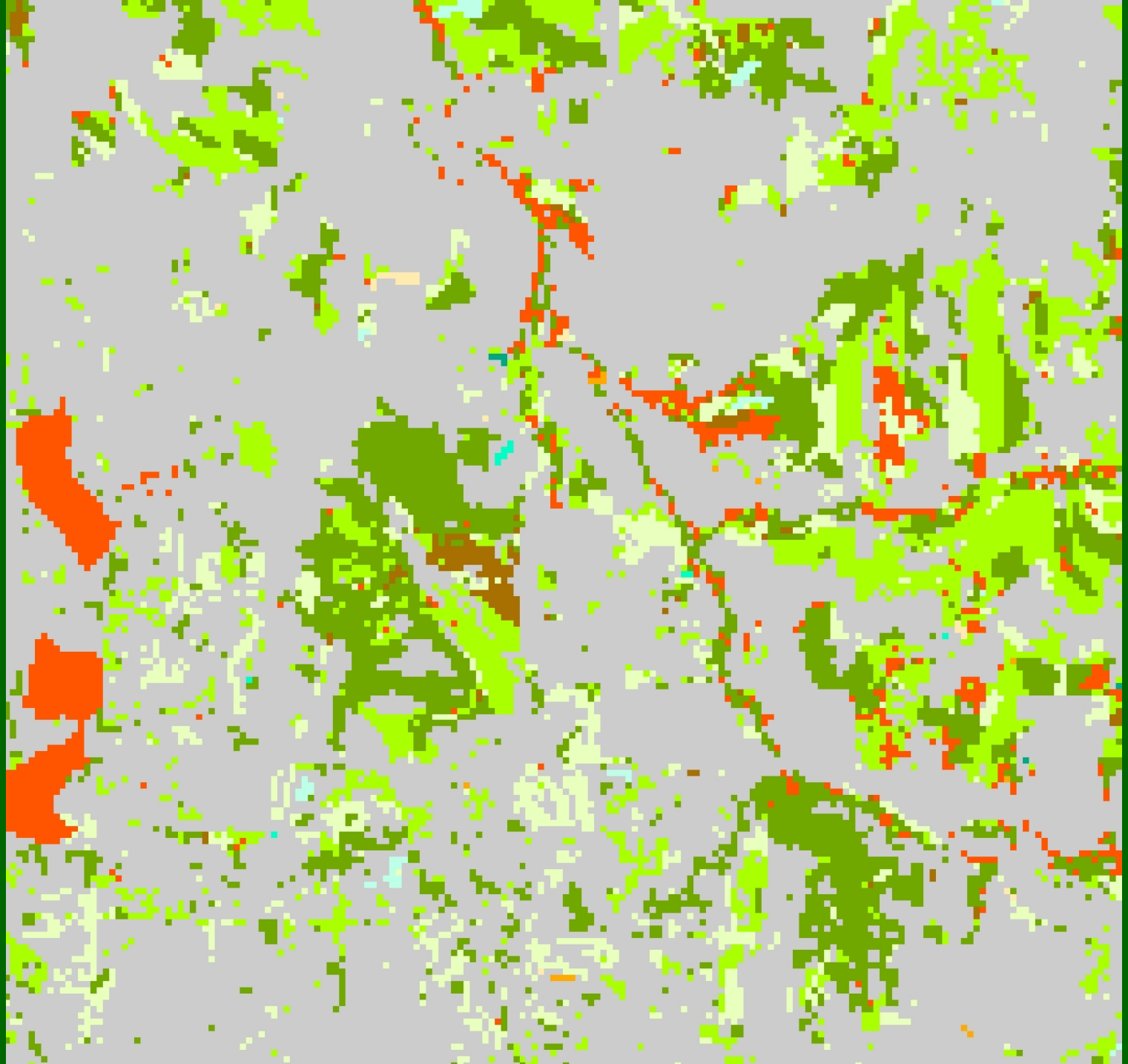
Forest Patch Size Distribution

- J-shaped curve (diagonal line on log scale)
  - Lots of smaller patches, fewer large patches

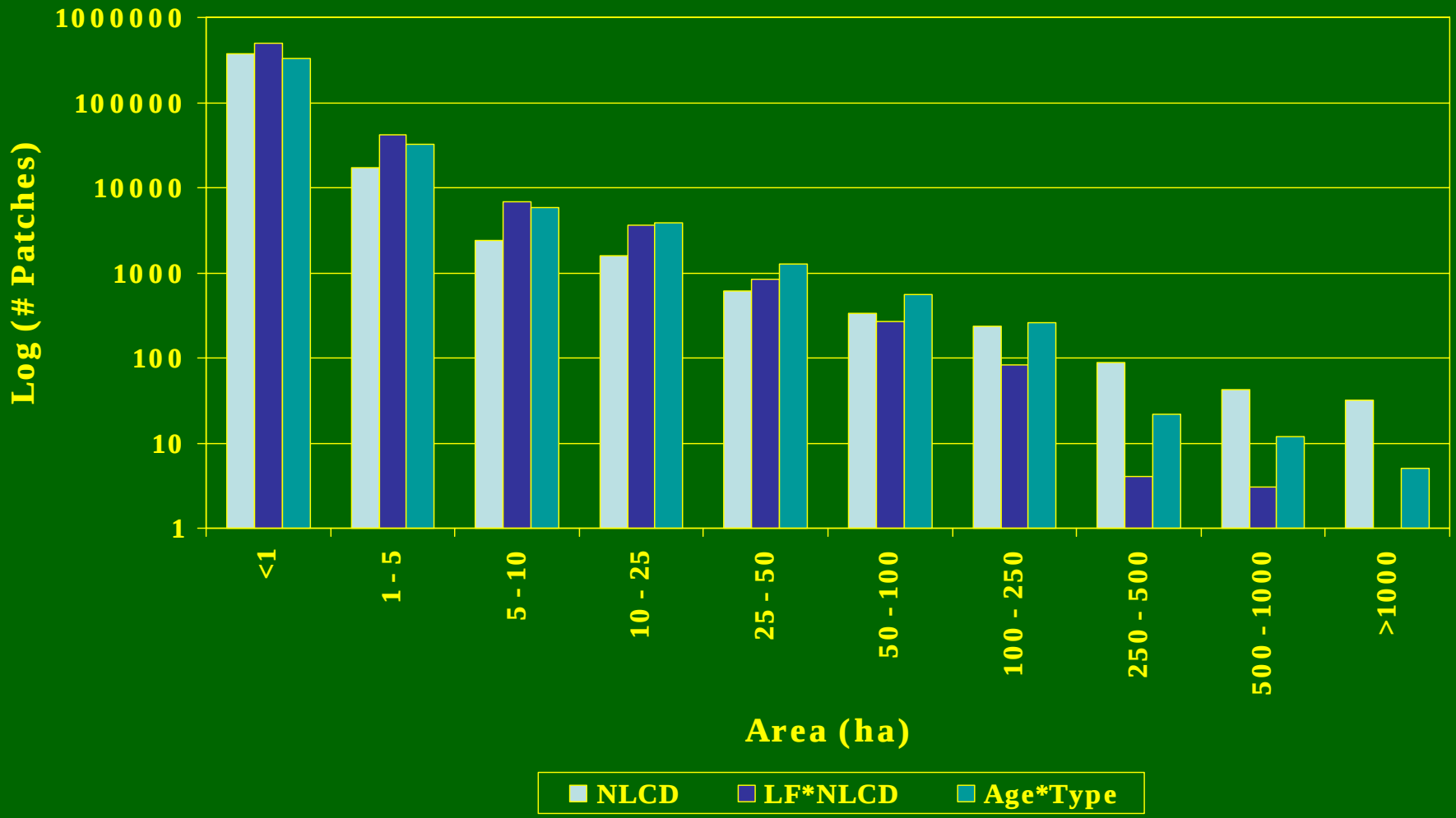


Populating Landscapes with FIA

- Forest patch-size distribution important for birds
  - Need to maintain J-shaped curve
- Assign primary attributes to patches
  - GIS-based (NLCD or NLCD*Landform)
    - Currently using NLCD*Landform map
  - Ancillary (Ownership, disturbance sizes, etc.)
- Assign secondary attributes to pixels



Forest Patch Size Distribution



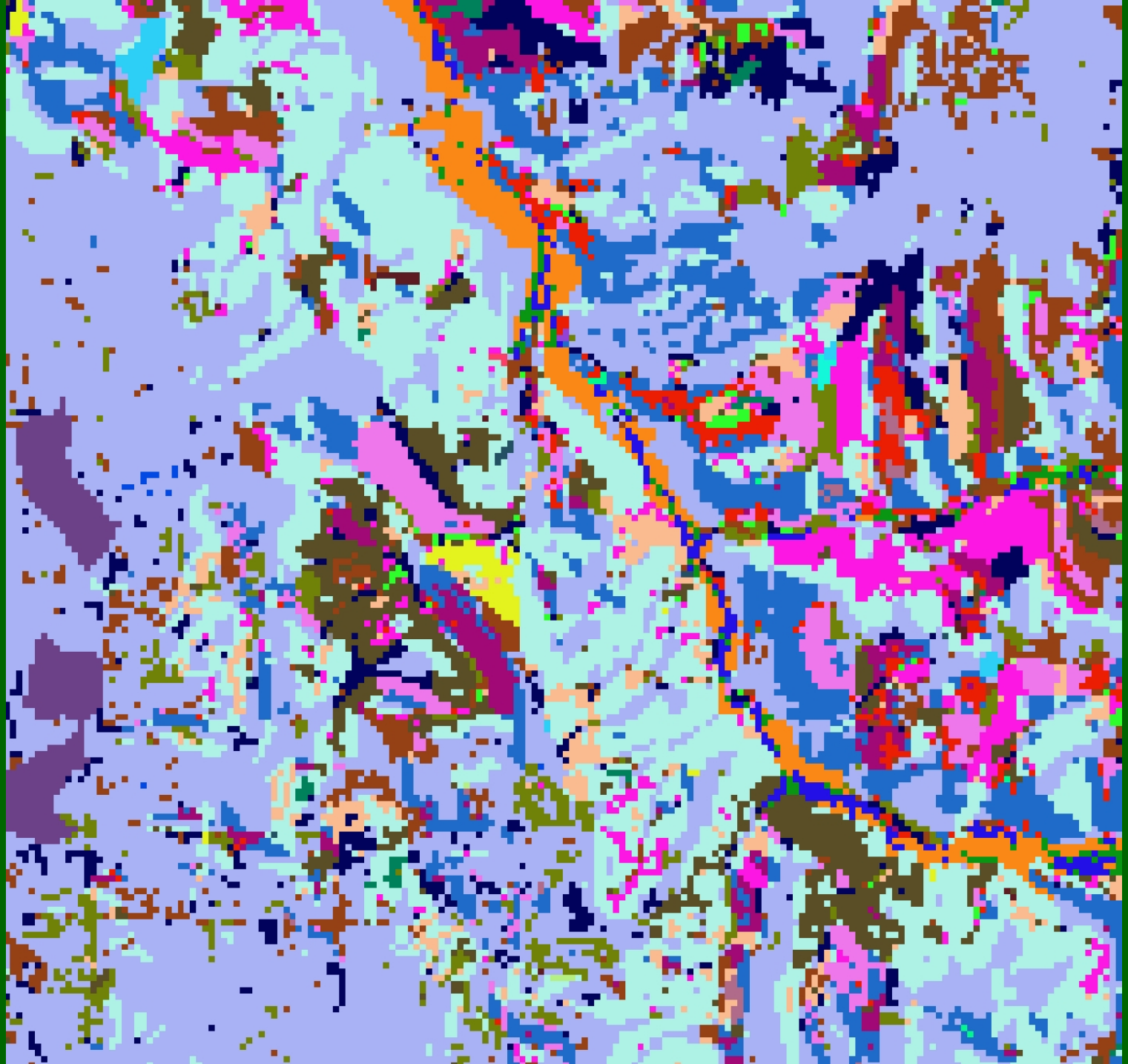
Yellow-throated Warbler Example

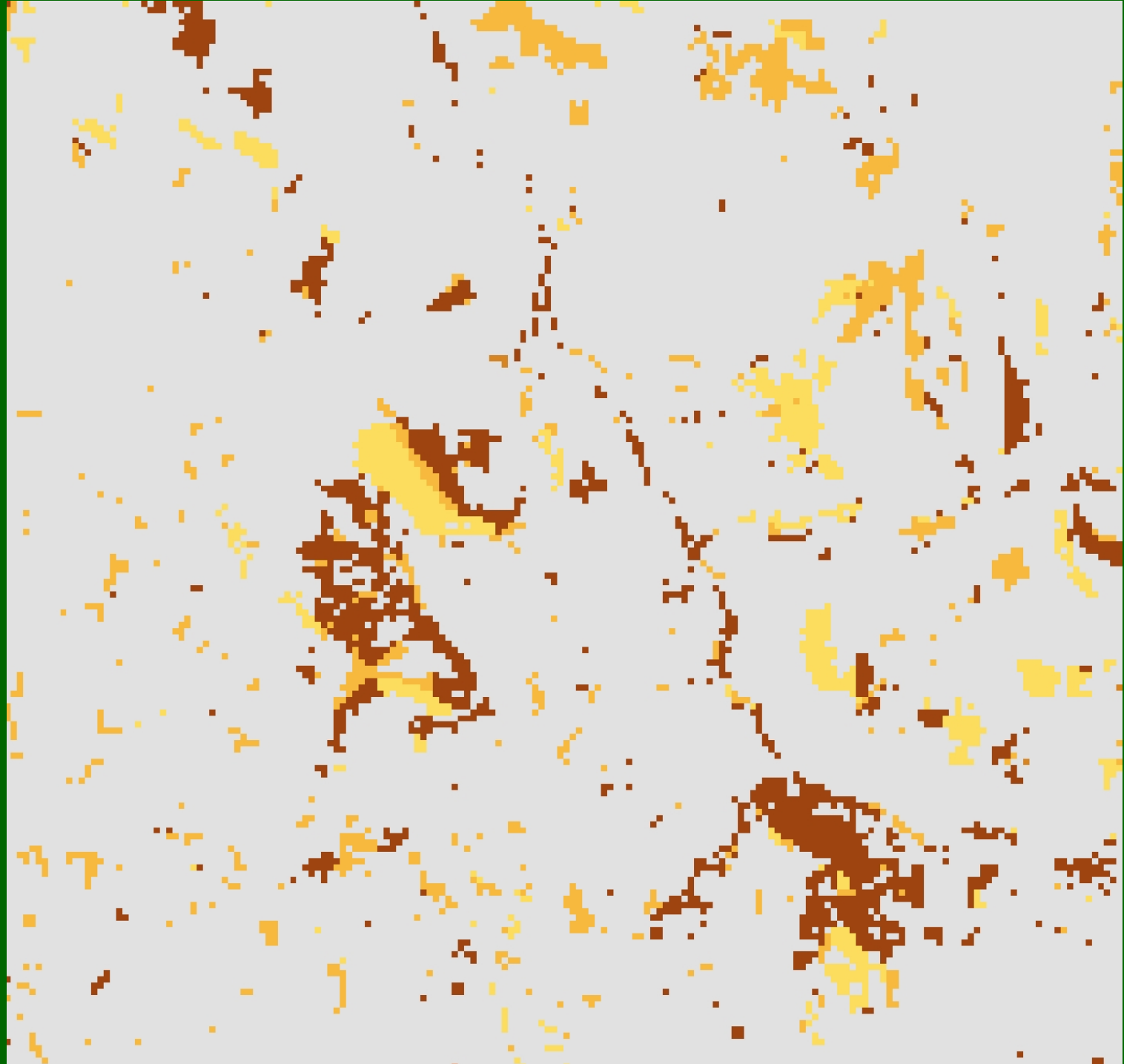
- SI1: Forest Type, Age Class, & Landform
  - Highest densities in bottomlands and swamps (Hamel 1992)
- SI2: Density of Large Trees
  - Nests in larger trees of mature stands (Hamel 1992, Robbins et al. 1989)
- SI3: Distance to Water
  - Tends to nest near water (Hall 1996, Hamel 1992)
- Relative Density = $(SI1*SI2*SI3)^{0.3}$

Yellow-throated Warbler SI1

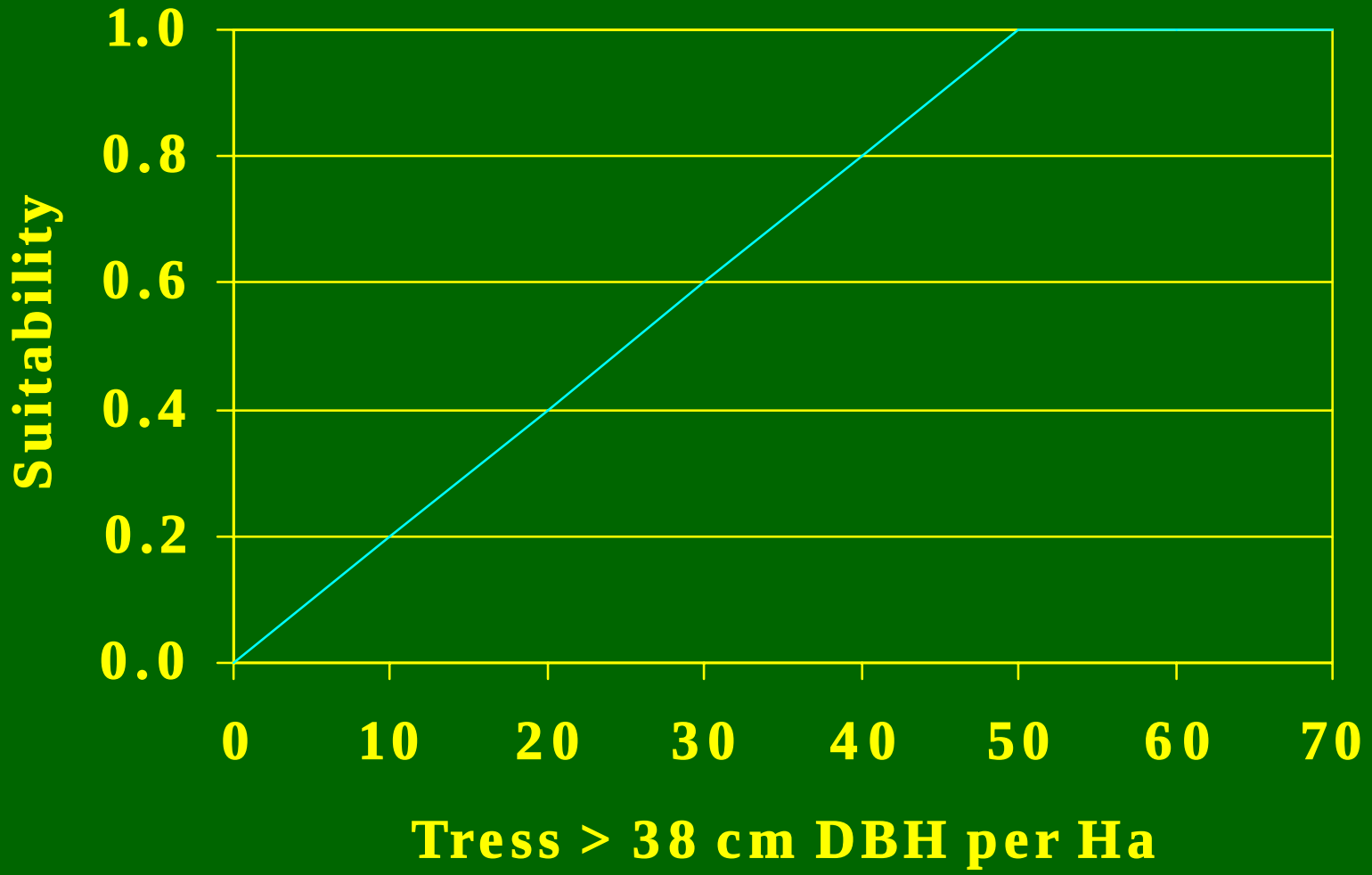
Influence of landform, forest type, and age class on relative density of yellow-throated warblers.

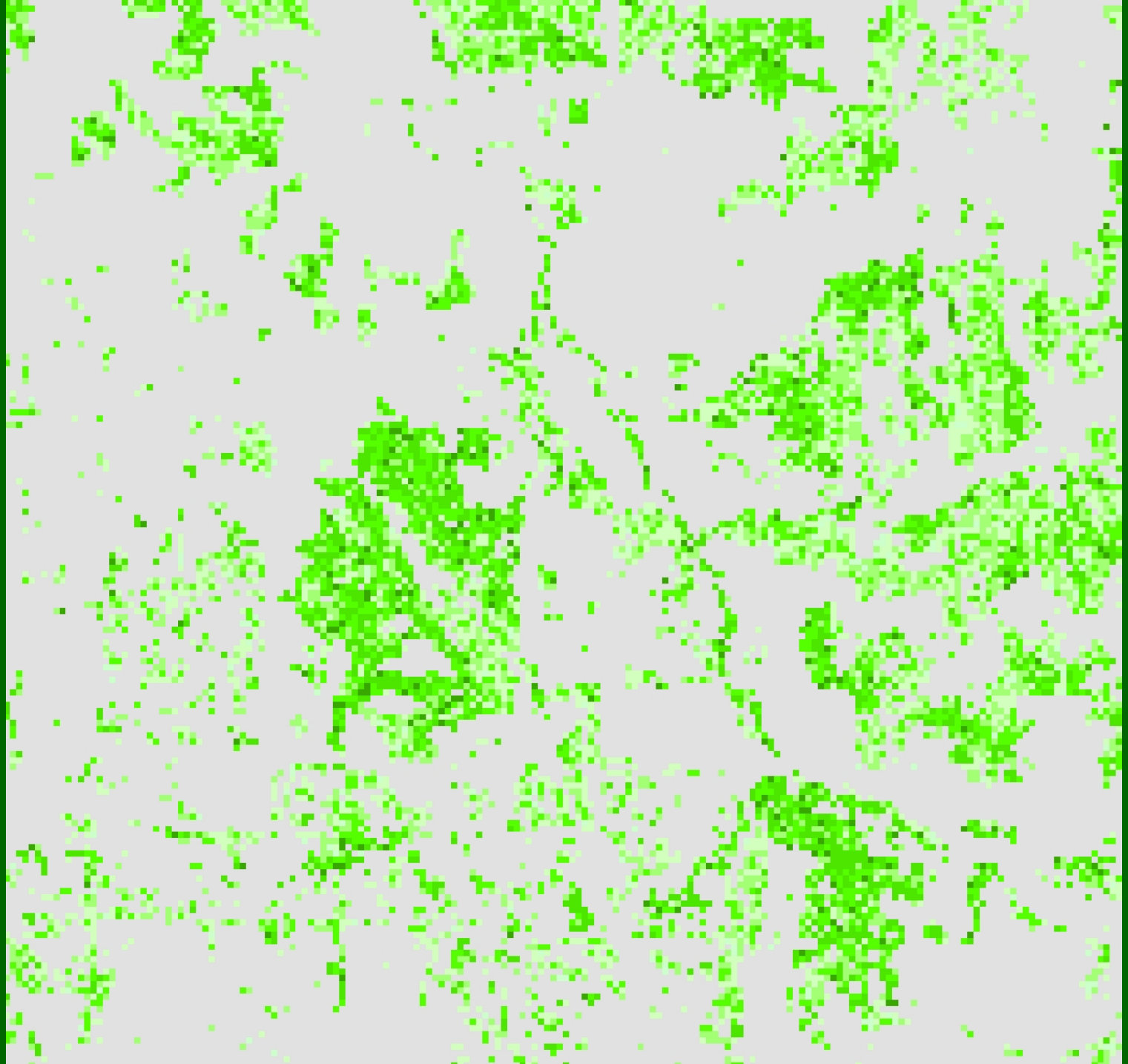
		Age class		
Landform	Forest type	Sapling	Pole	Sawtimber
Mesic/valley/ floodplain	Woody wetlands	0.000	0.000	1.000
	Deciduous	0.000	0.000	0.800
	Mixed	0.000	0.000	0.450
	Evergreen	0.000	0.000	0.100
Terrace	Woody wetlands	0.000	0.000	0.300
	Deciduous	0.000	0.000	0.240
	Mixed	0.000	0.000	0.135
	Evergreen	0.000	0.000	0.030
Xeric/ridge	Woody wetlands	0.000	0.000	0.100
	Deciduous	0.000	0.000	0.080
	Mixed	0.000	0.000	0.045
	Evergreen	0.000	0.000	0.010

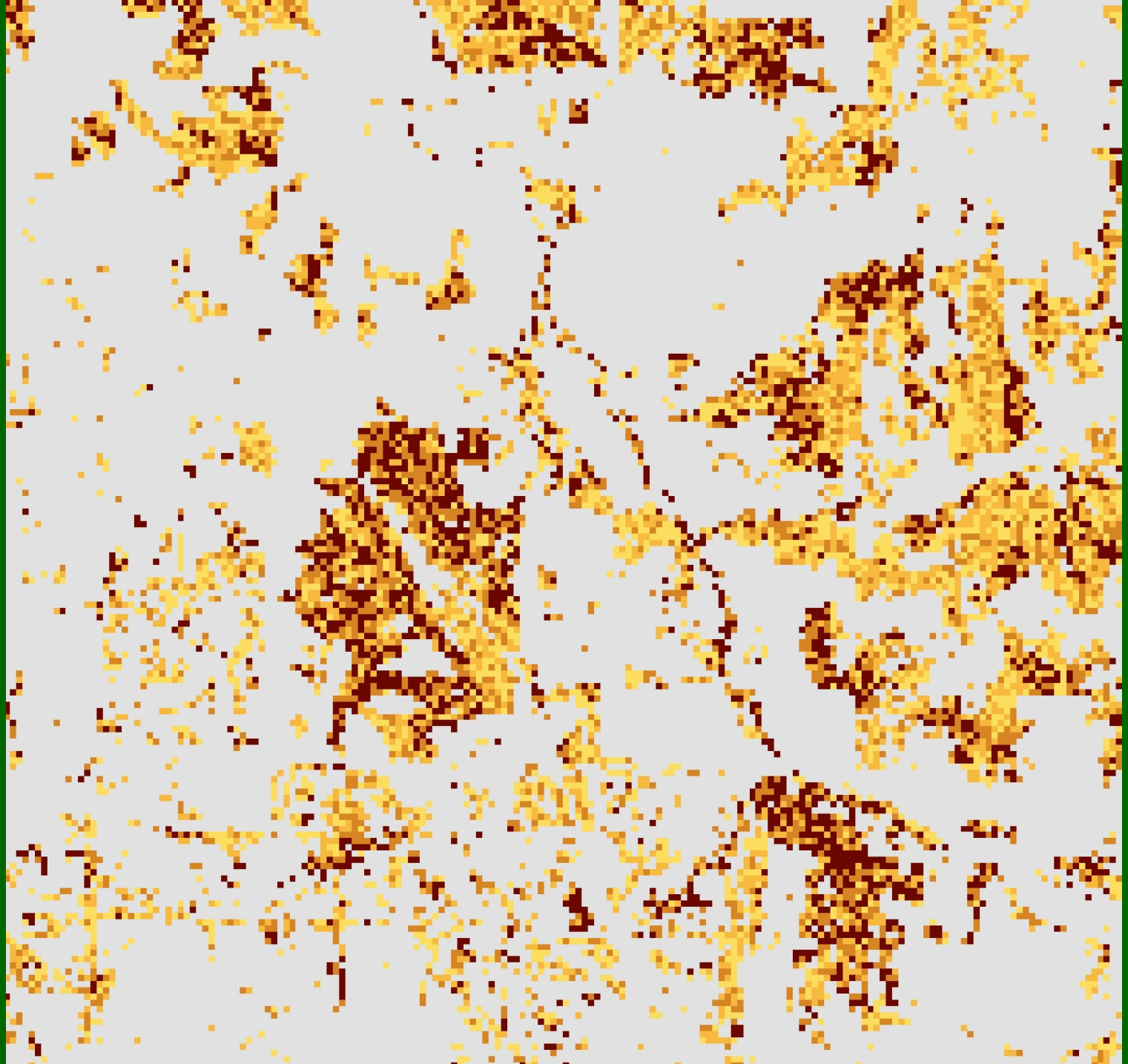




Yellow-throated Warbler SI2



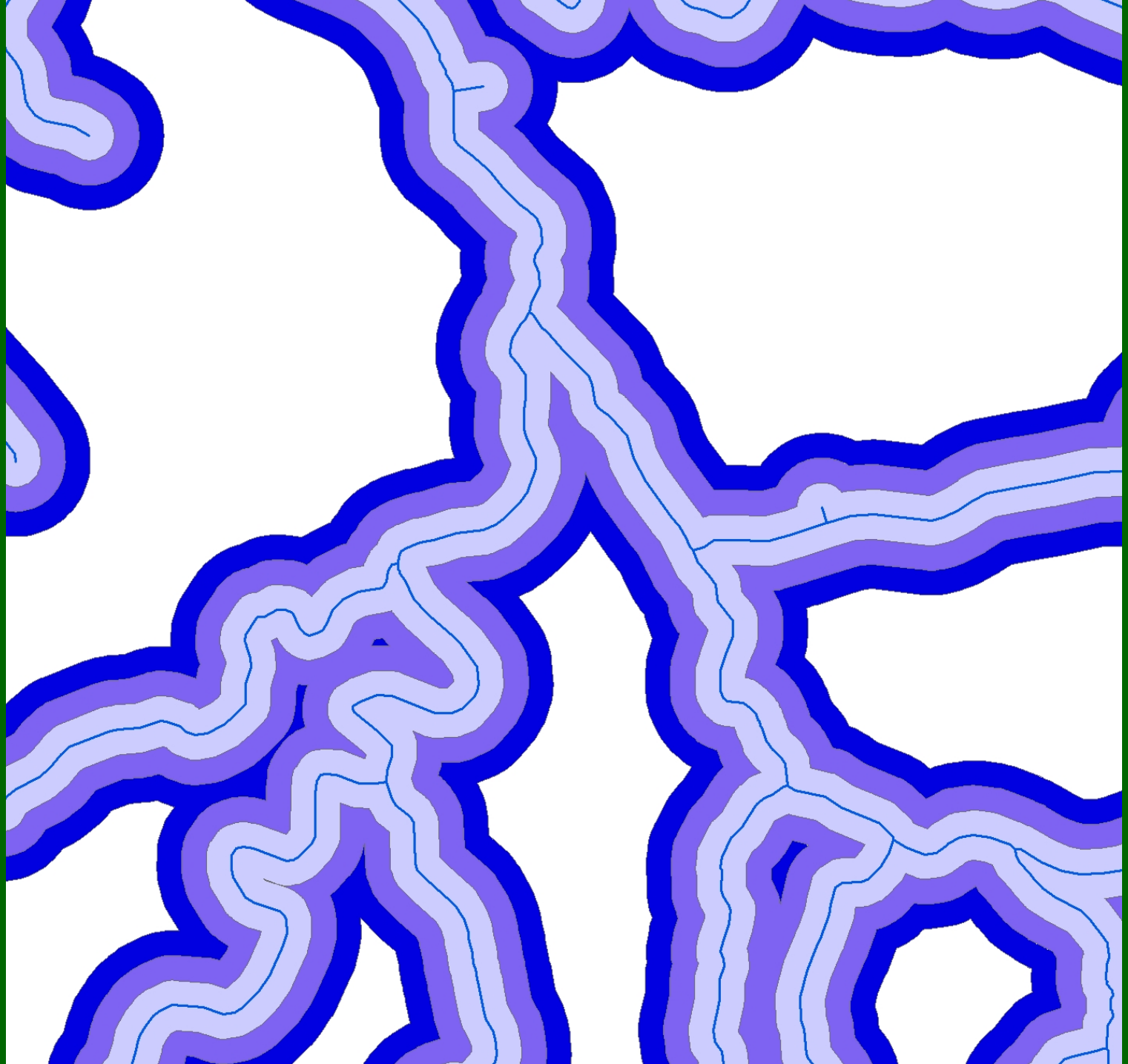


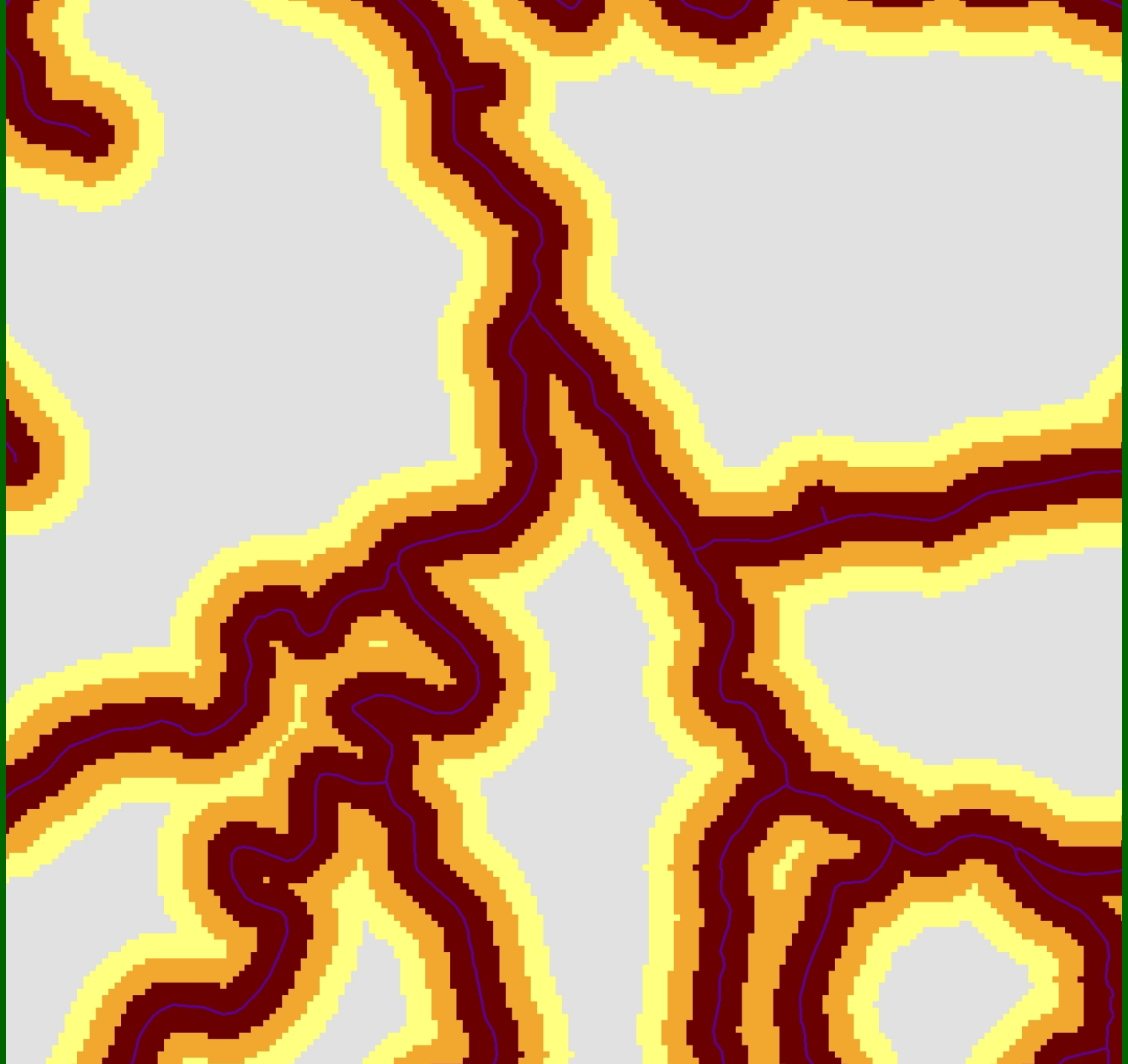


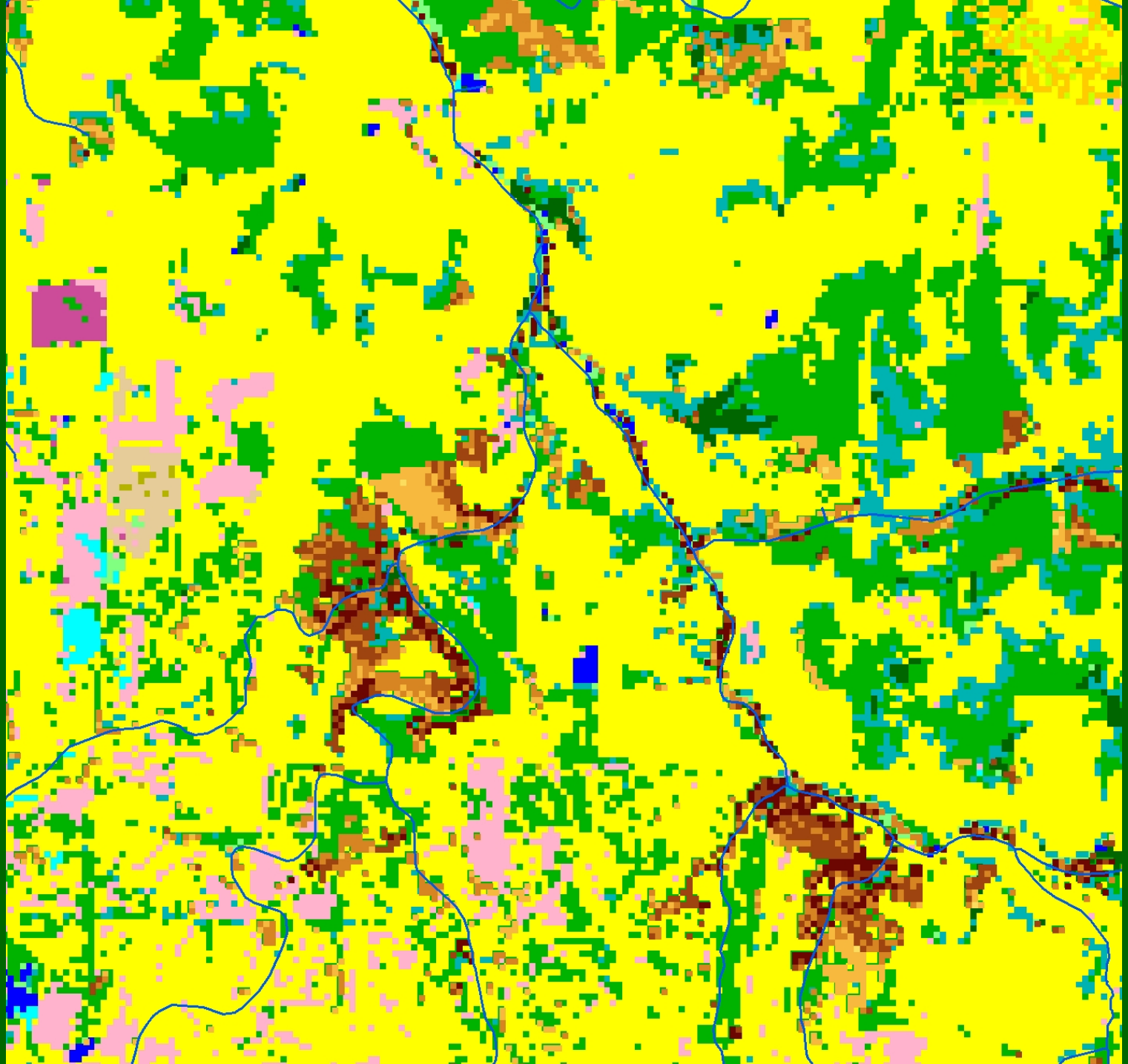
Yellow-throated Warbler SI3

Influence of distance to stream (m) on relative productivity of yellow-throated warblers.

Distance to edge (m)	Relative productivity
0-120	1.000
120-240	0.750
240-360	0.500
>360	0.000



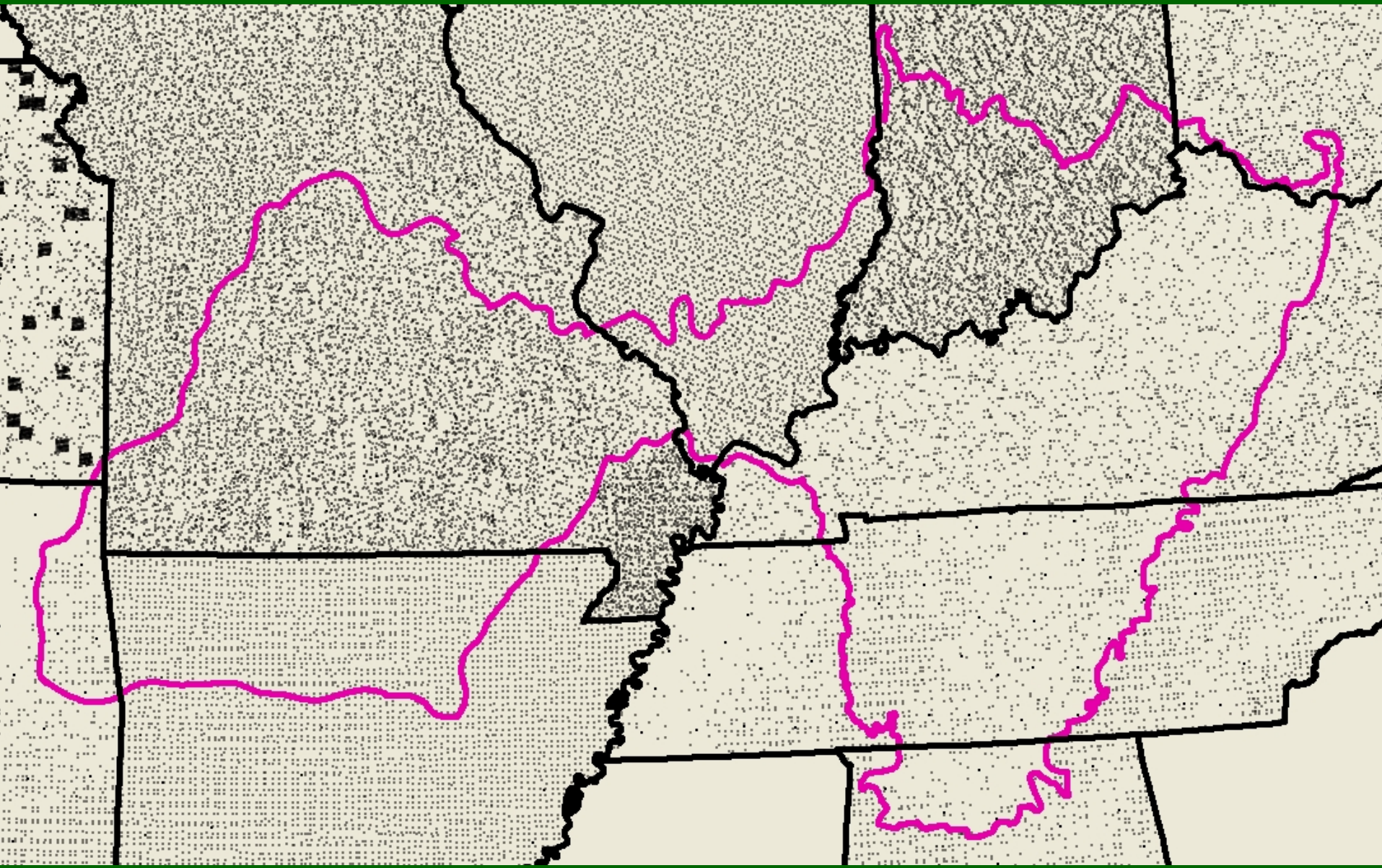




Caveats

- Data issues
  - Fuzzy plot locations
  - Periodic vs. annual survey cycles
  - Plot density

FIA – 1988-1995



Caveats

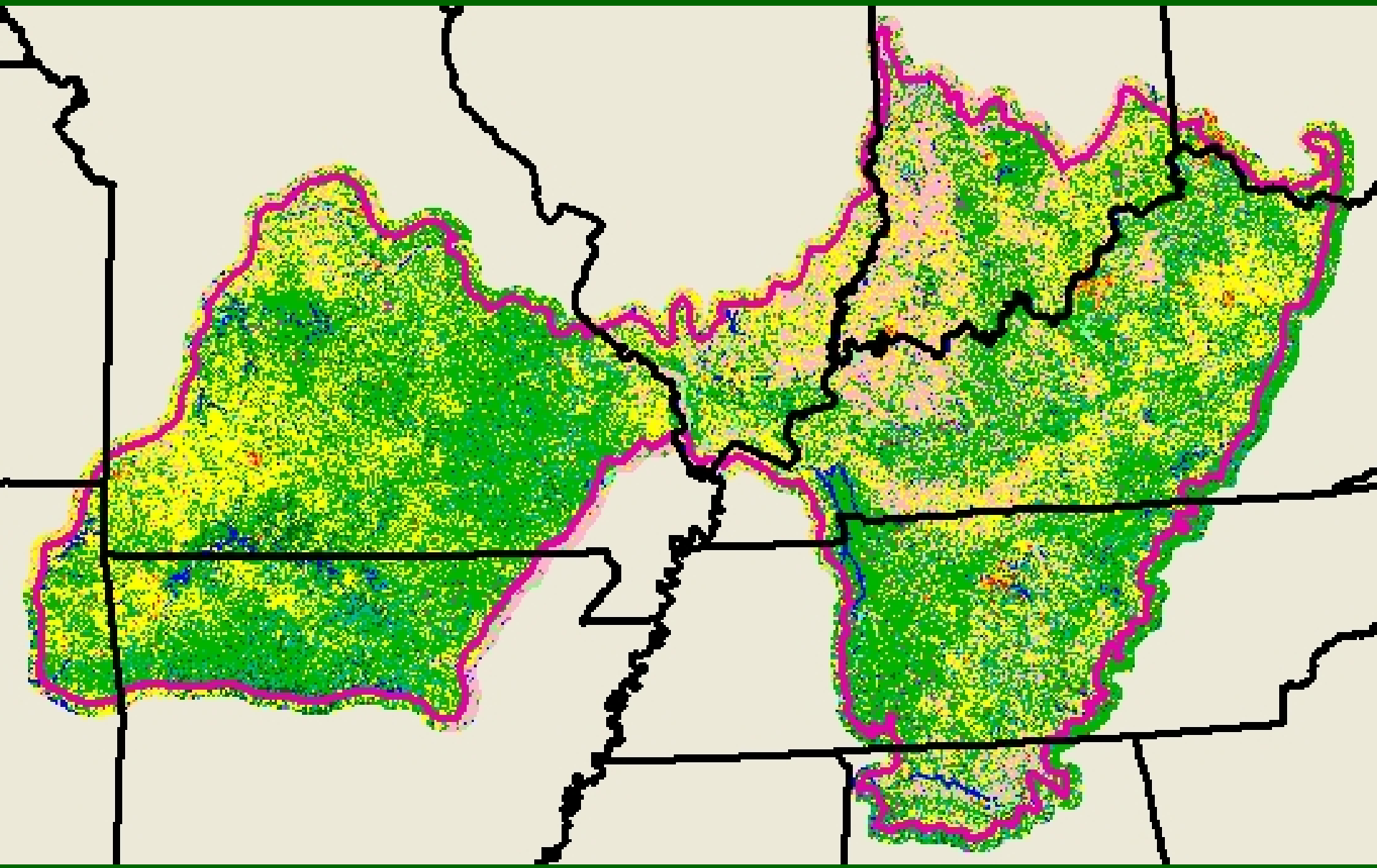
- Data issues
- Spatially explicit vs. Spatially exact
  - Scale of interpretation
    - Ecological sub-sections
    - Not for site management plans
  - Scale of application
    - 30 m^2 pixels
    - Processing time and memory

Opportunities

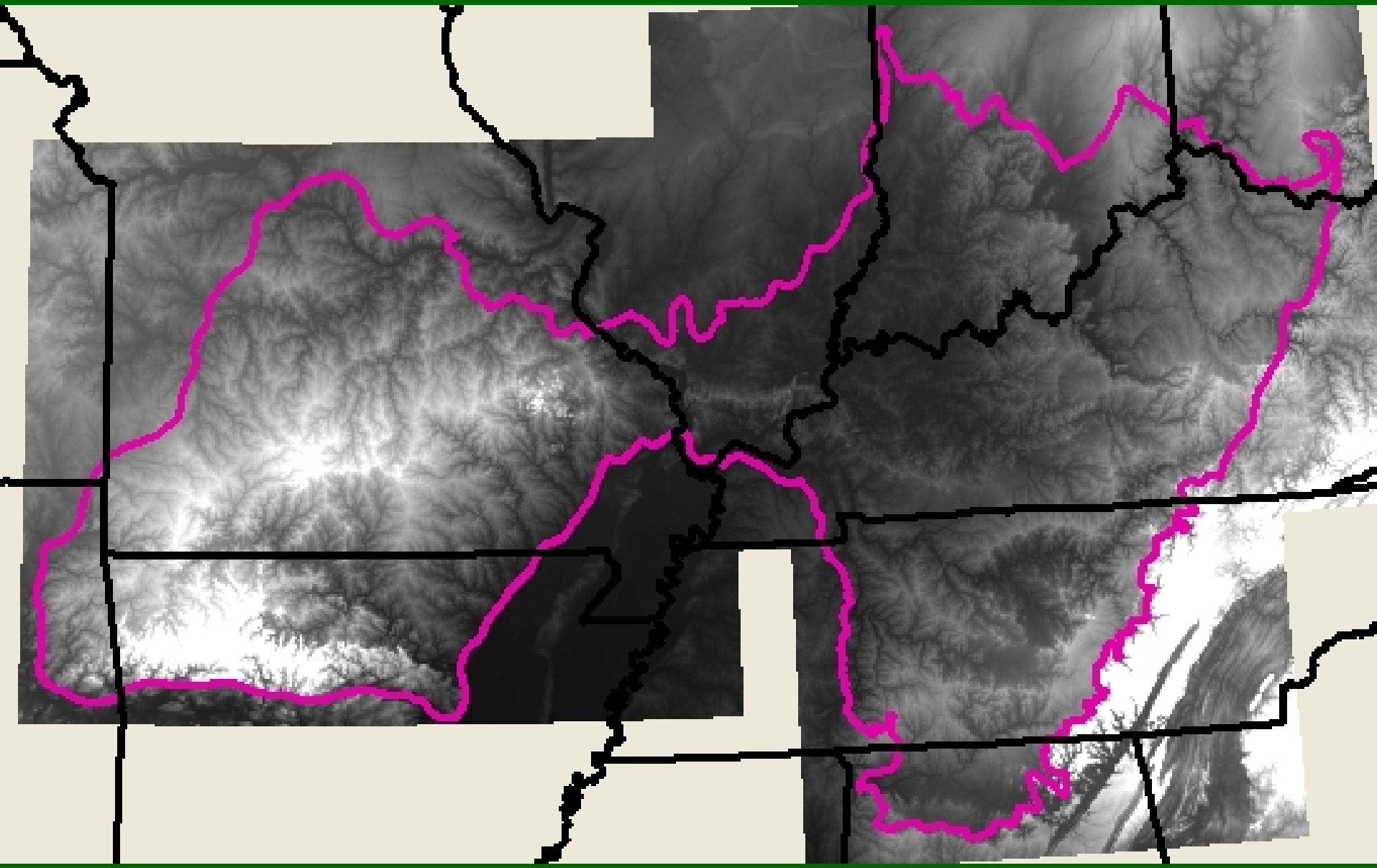
- Modeling habitat condition
- FIA and NLCD updates
  - Analysis of landscape change
- Simulation modeling
  - Monte Carlo
  - LANDIS
- Other species

Questions?

NLCD



NED



Landforms